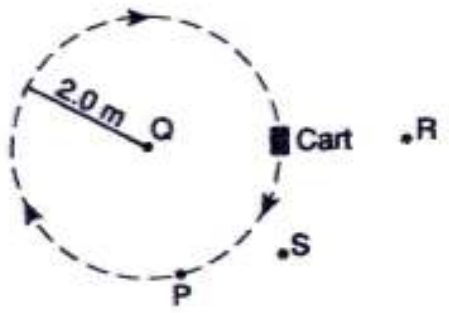
Base your answers for questions **1** and **2** on the following information. The diagram shows a 5.0-kilogram cart traveling clockwise in a horizontal circle of radius 2.0 meters at a constant speed of 4.0 meters per second.



1. If the mass of the cart was doubled, the magnitude of the centripetal acceleration of the cart would be
   (1) unchanged (3) halved
   (2) doubled (4) quadrupled

2. At the position shown, the velocity of the cart is directed toward point
   (1) *P* (3) *R*
   (2) *Q* (4) *S*

3. Base your answer on the information below.

   A 100-kilogram satellite moves in a circular orbit around the Earth at a distance of one Earth radius (**r**) above the Earth's surface. The satellite is moving at speed **v**.

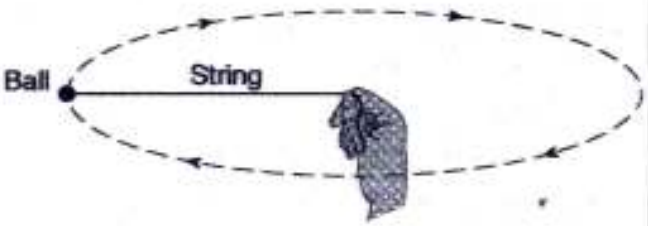
   The centripetal acceleration of the satellite can be expressed as
   (1) $a = \frac{f}{m}$ (3) $a = \frac{v}{t}$
   (2) $a = \frac{v^2}{2r}$ (4) $a = \frac{v^2}{\sqrt{r}}$

4. Base your answer on the diagram below which represents a 4.0×10^2-kilogram satellite, S, in a circular orbit at an altitude of 5.0×10^6 meters. The orbital speed of the satellite is 6.0×10^3 meters per second and the radius of the Earth, *R*, is 6.4×10^6 meters.

   The centripetal acceleration of the satellite is closest to
   (1) 9.8 m/s^2 (3) 3.2 m/s^2
   (2) 4.9 m/s^2 (4) 1.6 m/s^2

D9

Base your answers for questions **5** through **7** on the diagram below. The diagram shows a student spinning a 0.10-kilogram ball at the end of a 0.50-meter string in a horizontal circle at a constant speed of 10. meters per second. [Neglect air resistance.]

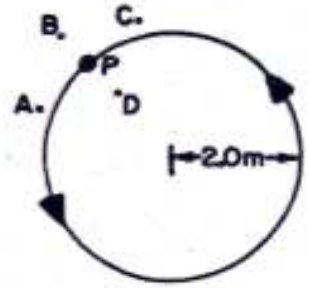


5. If the magnitude of the force applied to the string by the student's hand is increased, the magnitude of the acceleration of the ball in its circular path will
   (1) decrease
   (2) increase
   (3) remain the same

6. The magnitude of the centripetal force required to keep the ball in this circular path is
   (1) 5.0 N
   (2) 10. N
   (3) 20. N
   (4) 200 N

7. Which is the best description of the force keeping the ball in the circular path?
   (1) perpendicular to the circle and directed toward the center of the circle
   (2) perpendicular to the circle and directed away from the center of the circle
   (3) tangent to the circle and directed in the same direction that the ball is moving
   (4) tangent to the circle and directed opposite to the direction that the ball is moving

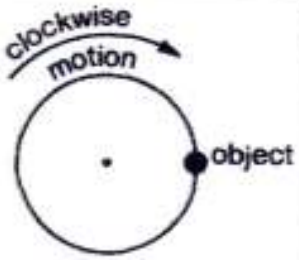
8. Base your answer on the diagram below which shows the path of an object moving counterclockwise in a circle of radius 2.0 meters. The speed of the object is 6.0 meters per second and the mass of the object is 0.2 kilogram.



When the object is at point *P*, the direction of the acceleration of the object is toward point
   (1) *A*
   (2) *B*
   (3) *C*
   (4) *D*

D10

9. The diagram to the right shows an object traveling clockwise in a horizontal, circular path at constant speed.



Which arrow best shows the direction of the centripetal acceleration of the object at the instant shown?

(1) ←

(2) →

(3) ↓

(4) ↑

10. An object traveling with uniform circular motion has a centripetal acceleration due to the change in

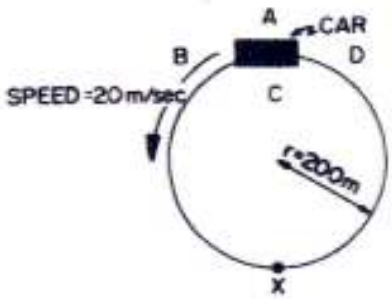
(1) speed

(2) direction

(3) kinetic energy

(4) mass

11. Base your answer on the diagram below which represents a car of mass 1,000 kilograms traveling around a horizontal circular track of radius 200 meters at a constant speed of 20 meters per second.



When the car is in the position shown, the direction of its centripetal acceleration is toward

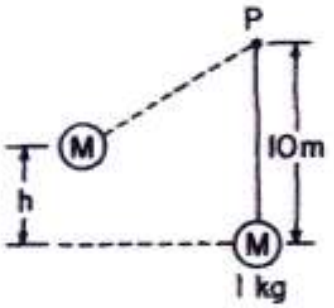
(1) *A*

(2) *B*

(3) *C*

(4) *D*

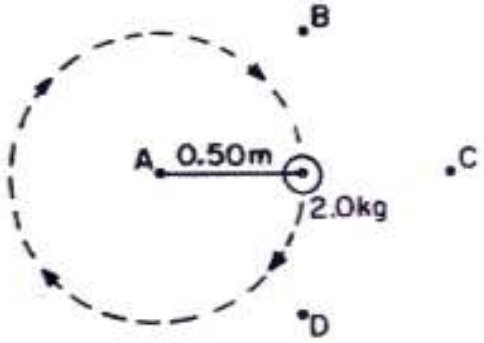
Base your answers for questions **12** and **13** on the diagram below which represents an object *M* suspended by a string from point *P*. When object M is swung to a height of *h* and released, it passes through the rest position at a speed of 10 meters per second.



12. The centripetal force on object M could be halved as it passes through the rest position by doubling the
    (1) weight of the object, only
    (2) length of the string, only
    (3) height *h* and the weight of the object
    (4) the length of the string and the height *h*

13. The centripetal force on object M as it passes through the rest position is approximately
    (1) 10 N (3) 100 N
    (2) 50 N (4) 1,000 N

Base your answers for questions **14** and **15** on the diagram below which represents a 2.0-kilogram mass moving in a circular path on the end of a string 0.50 meter long. The mass moves in a horizontal plane at a constant speed of 4.0 meters per second.

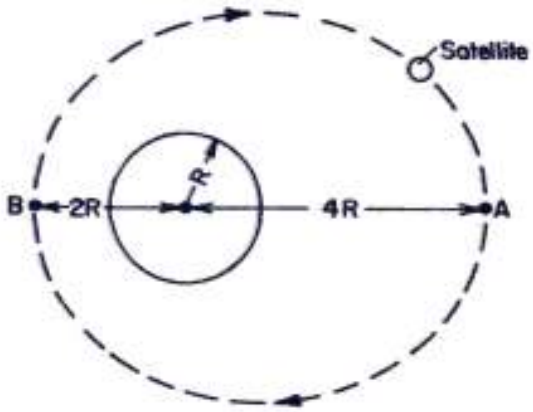


14. The force exerted on the mass by the string is
    (1) 8 N (3) 32 N
    (2) 16 N (4) 64 N

15. In the position shown in the diagram, the momentum of the mass is directed toward point
    (1) *A* (3) *C*
    (2) *B* (4) *D*

D12

16. Base your answer on the diagram below which represents a satellite in an elliptical orbit about the Earth. The highest point, *A*, is four Earth radii (4R) from the center of the Earth. The lowest point, *B*, is two Earth radii (2R) from the center of the Earth. The mass of the satellite is 3.0×10^6 kilograms.



Which vector represents the direction of the centripetal force on the satellite at *B*?

(1) →

(2) ←

(3) ↑

(4) ↓

17. A satellite is moving at constant speed in a circular orbit about the Earth, as shown in the diagram below.

The net force acting on the satellite is directed toward point

(1) *A*

(2) *B*

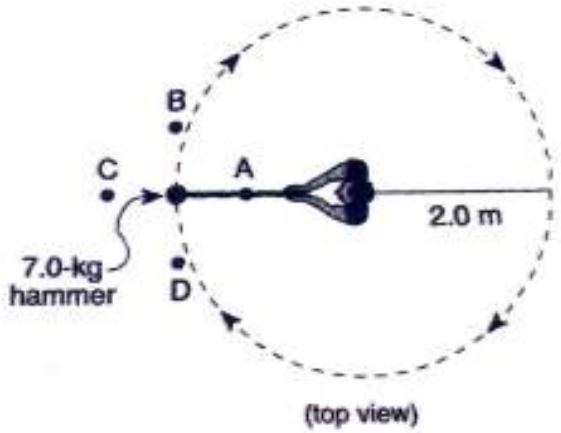
(3) *C*

(4) *D*

D13

Base your answers for questions **18** and **19** on the information and diagram below.

An athlete in a hammer-throw event swings a 7.0-kilogram hammer in a horizontal circle at a constant speed of 12 meter per second. The radius of the hammer's path is 2.0 meters



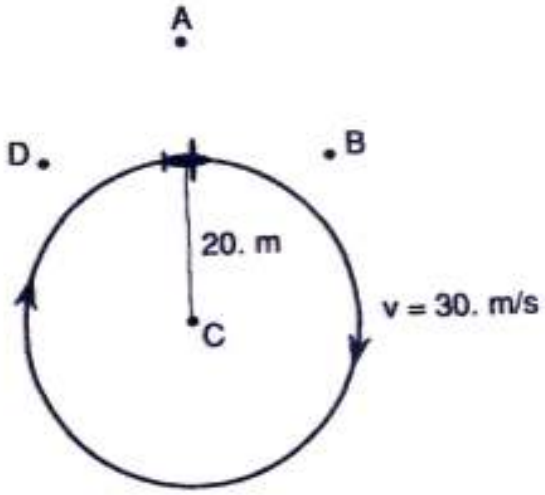
18. At the position shown, the centripetal force acting on the hammer is directed toward point

(1) *A* (3) *C*
(2) *B* (4) *D*

19. If the hammer is released at the position shown, it will travel toward point

(1) *A* (3) *C*
(2) *B* (4) *D*

20. Base your answer on the diagram below which shows a 2.0-kilogram model airplane attached to a wire. The airplane is flying clockwise in a horizontal circle of radius 20. meters at 30. meters per second.



If the wire breaks when the airplane is at the position shown, the airplane will move toward point

(1) *A* (3) *C*
(2) *B* (4) *D*

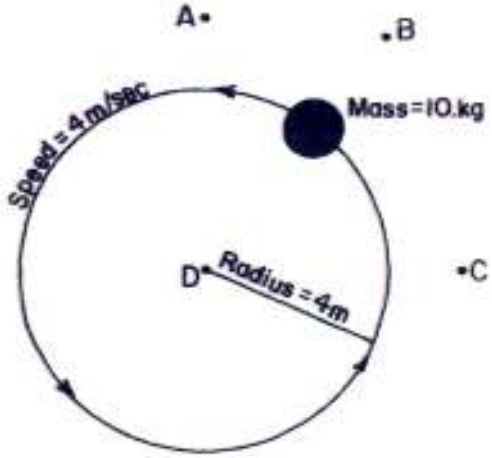
If the string breaks when the object is at point X, which arrow below best represents the path of the object after the string has broken?

(1) 

(3) 

(2)

(4) 

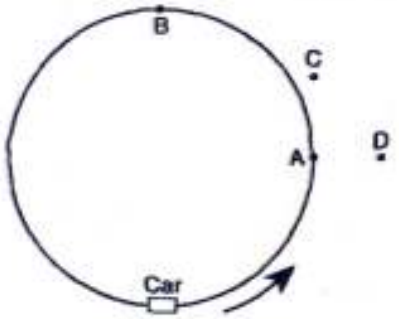


Which quantity would increase if the radius increased?

(1) period
(2) tangential velocity
(3) mass
(4) centripetal acceleration

D15

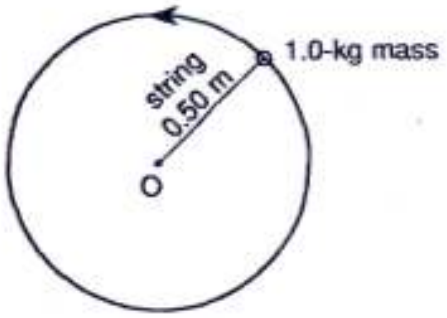
23. A convertible car with its top down is traveling at constant speed around a circular track, as shown in the diagram below.



When the car is at point *A*, if a passenger in the car throws a ball straight up, the ball could land at point

(1) *A*
(2) *B*
(3) *C*
(4) *D*

24. Base your answer on the diagram below which shows an object with a mass of 1.0 kilogram attached to a string 0.50 meter long. The object is moving at a constant speed of 5.0 meters per second in a horizontal circular path with center at point *O*.



If the string is cut when the object is at the position shown, the path the object will travel from this position will be

(1) toward the center of the circle
(2) a curve away from the circle
(3) a straight line tangent to the circle